THURSDAY, AUGUST 17, 1893.

OLD AND NEW ASTRONOMY.

Old and New Astronomy. By Richard A. Proctor, completed by A. Cowper Ranyard. (London: Longmans, Green and Co., 1892.)

AS originally designed by Mr. Proctor, this work was to contain a complete account of the Old and New Astronomy, particular attention being paid to the latter portion, which he wished to make a special feature of the book. It was to be issued in twelve monthly parts, the first of which duly appeared in March 1888; but unfortunately Mr. Proctor did not live to complete what he intended to be his *magnum opus*, and at the time of his death in September 1888 only seven parts were in type and the manuscript of the chapters on the planets well advanced. Although a considerable proportion of the materials for the chapters on the new astronomy had been collected, nothing had been written for that portion of the book. Mr. Ranyard undertook to complete the work, and as we now have it five-sixths of the book deals with the ancient and old astronomy, and is due to Mr. Proctor; while the remaining portion by Mr. Ranyard deals with some of the work and problems of the new astronomy. Unfortunately the book had grown to such an enormous size that promised chapters on meteors and comets were omitted and we have the strange anomaly of a work on astronomy in which neither of these important phenomena are dealt with.

It is to be regretted that Mr. Ranyard, in finishing the book, did not attempt to draw up a list of the errata which "must inevitably occur in a work of this kind," and that he did not see fit to add in some places details of important points, the original omission of which was probably accidental. For instance, in the first chapter, which gives an account of ancient and modern methods of observing the heavenly bodies, we find it indicated that the reflecting telescope suffers from chromatic aberration (page 45); and although stress is laid on the "amazingly exact system of modern measurement" the two essential instruments, the filar micrometer and the chronograph, are not even mentioned. Later on, in dealing with spectroscopy, the diffraction grating is not dealt with, and there is no mention of the grating spectroscope. We venture to think that no work on astronomy can be considered complete in which such essentials to the proper comprehension of the subject are omitted.

In the chapters on the shape of the earth, the apparent motions of the sun, moon, and planets, the true mechanism of the solar system, and the measuring and weighing of the solar system, we find Mr. Proctor probably at his best, the subjects being treated in considerable detail, although there is very little that has not already appeared in his earlier works.

Two chapters are devoted to the sun and its surroundings, and here Mr. Proctor differs from most of the authorities on the subject. He assumes that the formation of a spot is usually preceded by the formation of a facula, although the subject is still under discussion and the weight of evidence at present is distinctly in favour of the opposite conclusion. Now that Prof. Hale has enabled us to supplement our photographic study of sun-spots by photographs of all the faculæ on the solar disc, we may shortly hope to be able to fully trace the life history of solar disturbances in particular regions of the sun, and so to obtain a firm basis for a definite conclusion in the matter. We are also told in this chapter that we are forced to the conclusion that sun-spots are produced in the main by uprushes of intensely heated vapours from below the photosphere, but the generally accepted view is that spots are due to downrushes of comparatively cool matter from the regions above the photosphere. The main objection to the view that sun-spots are due to uprushes of intensely heated matter is that the bright lines in sun-spot spectra are few, and are not those usually associated with extremely high temperature.

The interesting chapter on the sun's surroundings is marred by personalities which render it practically impossible to consider this portion of the book as dispassionate scientific work. We may mention, however one error of fact which Mr. Ranyard should have corrected. On page 408 we are told that the eclipse of 1860 is remarkable as the first in which photography was employed to secure views of the corona, whereas Majocchi, at Milan, in 1842, had unsuccessfully tried this method of observation; and Berkowski, July 28, 1851, had obtained a perfectly successful picture showing the prominences and corona.

The chapters on the planets are, as might have been expected, very full and complete, but contain little that is new or calls for special comment. The method of illustrating the seasons on the earth by a series of diagrams, showing our planet as seen from the sun at 6 a.m., mid-day, 6 p.m., and midnight at Greenwich, on one day in each month, may, however, be noticed as certainly an advance on the very unsatisfactory method usually found in works on astronomy. It is also interesting to note that the moon is properly considered as a planet.

In the discussion of the temperature of the lunar surface, we are told that merely theoretical considerations could be thoroughly relied upon as proving that the temperature during the lunar day exceeds that of boiling water; and Lord Rosse's measurements which indicate a temperature of fully 500° Fahrenheit, are accepted, while those of Prof. Langley, which assign a temperature below freezing point, are rejected as being affected by some unknown cause of error. Later researches by Mr. Boys have, however, confirmed Prof. Langley's results, and it would have been an advantage had Mr. Ranyard noted this in the completed volume.

In the chapters on stars and the new astronomy Mr. Ranyard gives in the beginning a full account of parallax, and presents an interesting diagram showing the distances of all stars whose parallaxes have been determined during the present century. The theories of the earlier astronomers with regard to the construction of the stellar universe are passed in rapid review, due credit being awarded to the work of Thomas Wright, of Durham, who really anticipated many of the speculations of Sir William Herschel. The various later disc, ring, and spiral theories of the Milky Way are carefully discussed and compared with the latest researches of Prof. E. C. Pickering and Dr. Gould, the whole object of the work being obviously to give a full and fair statement of fact, without regard to any preconceived ideas or theories. The distribution of nebulæ is then considered, and a careful analysis made of the many wonderful structures shown in Dr. Robert's photograph of the great nebula in Orion. The great similarity of these forms to those traceable in the Solar Corona is clearly demonstrated, and it is suggested that just as the coronal forms probably have their origin in enormous streams of gaseous matter ejected into a resisting medium, so these similar structures may be due to a similar cause. Mr. Ranyard then shows how these forms are reproduced in the arrangement of clouds of stars in the Milky Way, as shown by the marvellous photographs taken by Prof. E. E. Barnard of the Lick Observatory, excellent reproductions of which illustrate this portion of the book. A detailed examination of Prof. Barnard's plates seems to Mr. Ranyard to indicate the existence of dark-absorbing matter, "either like cold gas or fog of opaque particles in space, cutting out or dimming down the light of the region beyond." These dark patches assume the curved forms and tree-like structure already referred to, and thus seem to further confirm the idea of a resisting medium, which, as Mr. Ranyard is careful to point out, need not necessarily be a gas; dust moving in space, or meteors, or large masses would equally offer resistance.

By deliberately overprinting photographs of the Milky Way, long chains of stars and curving dark lanes have been brought into great prominence, and have materially assisted in the investigation. There is certainly much to recommend this startling suggestion of dark absorbing matter in space, and the wonderful details of Prof. Barnard's photographs, and the similarity to coronal and nebular forms, can scarcely be explained as due to accidental groupings of stars and dark spaces in the Milky Way. Although most authorities, including Prof. Barnard himself, prefer to suspend their judgment in the matter until still more photographic results are available, there can be little doubt that no more satisfactory hypothesis has as yet been advanced.

The connection between nebulæ and bright stars, and the connection of bright stars with faint ones by means of thin wisps of nebulous matter, undoubtedly indicate that differences in magnitude of stars are due to differences of physical condition and not to distance. As illustrating the far reaching results of this conclusion Mr. Ranyard says:—

> "If we assume a distance fifteen times as great as the distance of *α* Centauri, for a part of the Milky Way in which a first magnitude star is found to be associated with stars of the 17½ magnitude, we must be prepared to assume a diameter for the large star twenty times as great as the solar diameter, unless its photosphere is brighter than the solar photosphere; while the smaller stars if their photospheres were as brilliant as the solar photosphere, would have diameters equal to about one-hundredth part of the solar diameter—that is, they would not much exceed the earth in magnitude."

The question of proper motion next receives attention, and this is followed by an account of binary and triple stars, most of the recent work being fully dealt with. In the discussion of stellar spectroscopy we find Secchi's classification of star spectra given to the exclusion of all others. Details of other systems might well have been introduced here, but it is evident that Mr. Ranyard considers the subject one in which very little advance towards a proper classification has been made. He is of opinion (p. 795) that the Sirian type are less condensed and are in an earlier stage than the solar type, and indicates that bright line stars must come somewhere between nebulæ and the Sirian type; but there is nothing to indicate whether he thinks this is the stage of rising or falling temperature, and the whole question is left in a vague and somewhat unsatisfactory manner.

In considering the supposed physical connection between the stars in the great nebula in Orion and the nebula itself, Mr. Ranyard relies on the fact that similar bright lines are found in the spectra of each, and quotes the photographs of Dr. Huggins as proving that these stars are physically bound up with the gaseous matter of the nebula. He himself seems inclined to the opinion that they are not condensations of the nebulæ, but are the centres from which the matter now forming the nebula was ejected; but whether condensations of the nebula or points of origin the spectra are supposed to be similar. It is important to remember, however, that it is nearly impossible to get a photograph of the spectrum of a star involved in a nebula without also obtaining a superposed spectrum of the nebula itself. Every tremor of the telescope sufficient to carry the star image off the slit will allow the nebula to imprint its spectrum on the plate, and if the star is allowed to trail along the slit it is clear that the nebula gets more exposure than the star at any particular point in the resulting photograph. There is at present no absolute photographic proof that the stars in the nebula in Orion contain the nebular lines as bright lines in their spectra, and consequently conclusions based on this assumption are untrustworthy.

Mr. Ranyard classes the nebulæ which give faint continuous spectra and do not show the characteristic green line, as white nebulæ, and places in this class the Andromeda nebula, the spiral in Canes Venatici, and the nebulous background of the Milky Way, but makes no suggestion as to the stage of development of these bodies.

On the question of "What is a nebula?" it is extremely difficult to understand the exact position assumed by Mr. Ranyard. He evidently considers nebulæ as containing solid or liquid matter and as increasing in temperature, but "the very great transparency" renders it probable that they either contain very little solid or liquid matter, or that the solid or liquid matter is aggregated into discrete masses with an average diameter of more than an inch; if the density of a nebula, leaving out of account its gaseous constituents, is as much as one one-thousand millionth of the density of atmospheric air at the sea level. These conclusions are practically an acceptance of the main idea of Lockyer's meteoritic hypothesis so far as it deals with nebulæ, although Mr. Ranyard rejects the spectroscopic evidence bearing on the point. The speculations as to the probable density of the Great Orion nebula, although extremely interesting, are vitiated by the fact that it is impossible to estimate the gravitational effect of the dark matter in interstellar space.

The book is well and copiously illustrated throughout, the plates and the photographic reproductions being of a very high-class character. Mr. Proctor's portion is written in his usual clear and popular manner, but the prevailing impression is decidedly that of disproportion. Too much space is occupied by the personalities which were unfortunately too frequently shown in his controversial methods, and by details of a comparatively unimportant character; while essentials are, as we have pointed out, frequently incompletely dealt with or even entirely omitted.

Mr. Ranyard's portion is admirably written, is very thoughtful and suggestive, and is a valuable contribution to our knowledge of the stellar universe and the condition and distribution of matter in external space. Indeed, the comparative brevity of this portion of the book is its chief fault, and a condensation of the earlier portion to allow of the expansion of this would greatly increase its value to the student, and would certainly not lessen its interest to the general reader. A. T.

EARTHQUAKES.

Erdbebenkunde. Die Erscheinungen und Ursachen der Erdbeben, die Methoden ihrer Beobachtungen. Von Dr. Rudolf Hoernes, o.ö. Professor der Geologie und Palæontologie an der Universität Graz. (Leipzig: Veit and Co., 1893.)

Étude sur les Tremblements de Terre. Par Léon Vinot. (Paris and Nancy: Berger-Levrault et Cie, 1893.)

IN a recent article in this journal, entitled "Seismology in Japan" (see NATURE, June 8, p. 136) attention was directed to the long series of memoirs which deal with the methods and results of earthquake-observation, and have appeared in the Transactions of the Seismological Society of Japan, or its successor, the *Seismological Journal of Japan*. Any advance in our knowledge of the phenomena or causes of earthquakes resulting from the study of the frequently occurring shocks in Japan is largely due to the untiring efforts of the editor of those journals, Prof. John Milne, and to those of the school of active seismologists, whom he has educated and inspired with some of his own enthusiasm. We can best judge, perhaps, how far advances of our knowledge on this difficult and obscure department of physics and geology have been real and of permanent value from the examination of text-books and general treatises, in which summaries are given of the latest and most important researches upon the subject.

The two works whose titles appear at the head of this article, and which have recently made their appearance in Germany and France respectively, may well serve the purpose of illustrating what is the high-water mark of our knowledge at the present time concerning these remarkable but little understood phenomena.

If we compare these two books with their numerous predecessors, the first peculiarity which strikes us is the classification of earthquake-phenomena, based on the supposed causes of the disturbance of equilibrium in the earth's solid crust, which have been adopted by the recent authors. While the older writers took for granted the close connexion between seismological and vulcanological phenomena, so that "earthquakes and volcanoes" were almost always discussed in the same treatise, the two works before us afford distinct evidence that this conviction has now been very seriously shaken. It is true that nearly all great volcanic outbursts have been attended by earth-tremblings; but it is equally true that some of the grandest displays of seismic energy have occurred in areas that have not at any recent period been the scenes of volcanic activity; and both the German and the French author admit the existence of great classes of seismic disturbances, which have no necessary connexion with any manifestations of volcanic energy.

Dr. Hoernes classifies earthquakes under the four headings: "Vulkanische Beben," "Einsturzbeben," "Dislocationsbeben," and "Relaisbeben." M. Vinot treats of them under the following heads:—"Tremblements de terre suivis, d'éruptions où liés directement à l'action volcanique;" "Tremblements de terre dus encore à l'action direct du feu central, mais sans manifestation consécutive du volcanisme;" and, lastly, "Tremblements de terre indépendent de l'action volcanique."

But with this recognition of the class of non-volcanic earthquakes the resemblance between these two books ceases. Dr. Hoernes commences his work with an admirable account of the speculations on the nature and causes of earthquake-phenomena which have appeared from the earliest times. His comprehensive sketch begins with extracts from the writings of Hebrew prophets and Greek philosophers, and ends with references to the Seismological Society of Japan. The two chapters which follow on earthquake-phenomena and earthquake-observation are clear and useful summaries of the most recent researches on the subject, and are well brought up to date. Supplied as they are with drawings and descriptions of seismographic apparatus, they afford one of the best guides with which we are acquainted to a general knowledge of the principles and methods of seismological investigation.

M. Vinot commences his work with a chapter on the nebular hypothesis and the proofs of the existence of central heat within the earth. He insists that, to explain the phenomena of earthquakes, it is necessary to assume the existence at a depth which certainly does not exceed "quelques centaines des kilomètres," of a mass of incandescent liquid materials, which he argues must consist of molten metals in which are dissolved certain gases. The subsequent chapters of his book are a series of deductions from these premises. It will thus be seen that the methods and plan of the German and French authors are about as diverse as can well be conceived. The German work abounds with references by means of which the student who is not satisfied with the summary statements in the text is enabled to put himself into communication with the memoirs of the original investigator whose views have been cited. The French work is simply a readable essay, in which we have none of these valuable aids to study. The illustrations of M. Vinot's book consist of several page plates, reproduced from photographs, and representing the now-destroyed terraces of Rotomahana in New Zealand and the country affected by the eruption of Tarawera but the connexion of these illustrations with the text is by no means obvious.

In two works so diverse in their plan and execution as are those before us, it is interesting to note yet another and somewhat unexpected feature which they present in